THE

AMERICAN NATURALIST

Vol. VI.—APRIL, 1872.—No. 4.

# THE USE OF AMPHIPLEURA PELLUCIDA AS A TEST-OBJECT FOR HIGH POWERS.

BY DR. J. J. WOODWARD. U. S. A.

OVER a year ago (February 1, 1871) the Surgeon General of the United States Army published a brief memorandum prepared by me, on the *Amphipleura pellucida* and its markings. This memorandum was accompanied by two photographs exhibiting the striæ of the diatom, as seen with a power of about one thousand diameters. The paper was republished in the "American Journal of Science and Arts" (May, 1871), and in the "London Monthly Microscopical Journal" (July 1871).

Since preparing the memorandum referred to, I have had occasion to use the *Amphipleura pellucida* a number of times as one of the means of comparing the high power objectives of various makers, and having found it, within certain limits, well adapted to this purpose, have thought the following remarks on its use would not be without interest to working microscopists.

Specimens mounted by various English preparers may readily be obtained from any of the large dealers in microscopical preparations. I have compared such modern slides with some of the original ones mounted by Messrs. Sollitt and Harrison, which I owe to the courtesy of Mr. W. S. Sullivant of Columbus, Ohio, with the sample in the first century of Eulenstein, and with other slides from various sources. I find all very much alike, the striæ usually varying from ninety to one hundred to the $\frac{1}{1000}$ of an inch. In a few large frustules I have found coarser striæ than the above

but finer ones in none. For the best use of the test it is essential that the frustules should be clean and mounted dry,* on the under surface of a very thin cover (not thicker than $\frac{1}{200}$ of an inch). In some of my slides the frustules are mounted between two thin covers, adhering to the upper one but I am not sure that this arrangement offers any decided advantages.

The first step in the practical use of this test, after obtaining a properly mounted specimen, is to select a frustule, to count the number of its striæ to the thousandth of an inch, and to record its position with a Maltwood's finder.

The frustule thus selected becomes a valuable unit of comparison between different objectives, the distinctness with which the striæ are shown indicating the definition of the glass, the manner in which the edges of the frustule are seen while the mid-rib and striæ are in focus showing the degree of penetration, and the appearance of the ends of the frustule when the centre is in focus giving a fair idea of the flatness of the field.

The illumination must be oblique, and the pencil of light must be thrown lengthwise along the frustule, which may be done by a common coal-oil lamp, with or without a small plano-convex lens, or other condensing apparatus, to concentrate the rays. This, however, is the least favorable mode of illumination, and will only succeed if very carefully used with the best objectives. Much better are the calcium and magnesium lamps, which may be condensed obliquely by means of a small plano-convex lens of one to three inches focal length. Either source of light gives a beautiful picture, the striæ being black on a white ground. The finest

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*This is essential to the *best* and *most beautiful* appearance; it is not, however, indispensable for resolution, nor does balsam mounting make resolution much more difficult. For example I obtain excellent resolution of the balsam mounted *Amphipleura pellucida* on the Museum Möller's type-plate by Beck's immersion 1-10; price £6 sterling. The striæ are distinct and easily counted but paler than on dry specimens. I desire, also, to draw attention to the fact that Count F. Castracane in a paper read before the Royal Microscopical Society, March 1, 1871, expressly states that the year before he had made a photograph of the balsam-mounted *Amphipleura pellucida* of Möller's type-plate, obtaining good resolution and counting the striæ, which he gives as 4,000 to the millimetre. For this purpose he used a No. 10 of Hartnack, illuminated with monochromatic sunlight obtained by a prism. His negative "was blurred and rather faintish, so that it would not give good positive images." The power was about 640 diameters. Afterwards he obtained the same results with a No. 10 of Nachet (Monthly Microscopical Journal, April, 1871, p. 176). I may add that the Hartnack's No. 11 belonging to the Museum (price 250 francs) gives excellent resolution of the Amphipleura of Möller's type-plate and of other balsam-mounted specimens belonging to our collection.

results, however, are attained by the light of the electric lamp or of the sun rendered monochromatic by passing through a saturated solution of the sulphate of copper in strong aqua ammoniæ and of about the eighth of an inch in thickness.

Of these methods, that by sunlight involves least trouble and expense, and may be best managed as follows:—Erect a perpendicular wooden screen about two feet square on one edge of a small table. Cut in this a circular hole an inch and a half in diameter at about the height of the under surface of the stage of the microscope. On the outside of this hole mount a small plane mirror which can be adjusted by passing the hand to the outside of the screen. On the inside, cover the hole with the ammonio-sulphate cell. (A piece of dark blue glass will answer the purpose though not so well.) Now move the table to a window through which the direct rays of the sun can fall upon the mirror, adjust this so as to throw a nearly horizontal pencil of parallel rays through the hole, and place the microscope in the shade of the screen in such a position that the parallel blue rays will fall on the under surface of the amphipleura slide at an angle of from fifty to seventy-five degrees with the plane of the slide (I suppose the frustule to be examined has first been found by ordinary day-light or lamp-light). Next place a small bull's eye or any other condenser of from one to three inches focal length (mounted on a separate stand or on a radial arm) in the parallel pencil in such a position as to concentrate the light, at the angle above indicated, upon the frustule under examination. After this nothing remains but to regulate the cover correction and the fine adjustment. The precise angle which should be given to the illuminating pencil will vary with the angle of aperture of the objective used. As a rule it should be less than half the angle of aperture of the objective, and 70° to 75° is the maximum angle which should be given even for objectives of 170° angle, a greater angle, distorting the image without improving the definition.

The same results can be obtained by using a heliostat to fix the direction of the solar rays, and obtaining obliquity by an achromatic condenser of from 130° to 150° suitably decentred. On account of the stability of the illumination this method is especially suitable for photographing the Amphipleura, but the simpler method above described answers every purpose if the object is to compare objectives.

As to the result I may say that I have not yet met an immersion lens by any first class American, English, or Continental maker of an actual focal length of $\frac{1}{8}$ inch or less which did not, in my hands, resolve the Amphipleura more or less satisfactorily. I have even succeeded with an immersion $\frac{1}{5}$ of Mr. Tolles' obtaining a good photographic negative of two frustules well resolved with only two hundred and fifty-six diameters. My friend, Dr. J. W. S. Arnold of New York, writes me that he has obtained resolution by a Wales's immersion $\frac{1}{6}$.

A great difference exists, however, as to the manner in which different objectives, even when of the same power and by the same maker, will exhibit them, and for myself I have obtained the best results only with the finest immersion glasses of Messrs. Wales, Tolles, and Powell and Lealand. Spencer's recent objectives I have had as yet no opportunity of trying. With dry objectives the task is more difficult, still I have succeeded tolerably with some of the dry objectives of the above makers, and it was as seen with dry objectives that Messrs. Sollitt and Harrison first observed the striæ, though they could have glimpsed them but imperfectly or they would not have set them down at one hundred and thirty thousand to the inch.

In illustration of the appearances which ought to be obtained by a first class immersion objective of adequate power, the liberality of the Editors of the NATURALIST enables me to present herewith a Woodbury print from a negative, representing portions of two Amphipleura frustules as seen by an immersion objective of Mr. Wm. Wales of Fort Lee, New Jersey, magnified about fifteen hundred diameters. The lower of the two frustules proved on a careful count in the microscope, to have ninety-five striæ to the $\frac{1}{1000}$ of an inch. This circumstance puts it in the power of every one to compare the two frustules, and to determine the precise magnifying power of the print.

The objective used was made by Mr. Wales nearly three years ago. It was named a $\frac{1}{30}$ but is in fact a lower power. On measurement I obtained the following data. Magnifying power, without eyepiece, at fifty inches distance from micrometer to screen eight hundred and ninety diameters uncovered, twelve hundred and fifty diameters at full correction for cover; angle of aperture at uncovered 110°, at full cover 130°; at uncovered the objective is, therefore, $\frac{1}{18}$ very nearly.

The photograph was taken without an eyepiece, the magnifying power being obtained by distance; owing to the moderate angle of the objective the picture was freer from diffraction fringes and consequently handsomer than any Amphipleura picture I had previously obtained, for this reason only it was selected for reproduction. Since it has been in the hands of the printer, however, it is only fair to say that I have obtained equally beautiful pictures with the same power by an objective made by Tolles of 140° angle, as well as by an objective of Powell and Lealand, both used without eyepieces. Copies of these pictures I have sent to the Editor of the department of microscopy of this journal for exhibition. I suspect each maker would claim that the picture by his objective was the best. For myself I regard them as nearly equally good, and think that to discriminate slight shades of excellence between objectives of this high grade, it is necessary either to give a much higher power, by distance or eyepiece, or else to use some more subtile test, such for example as the finer bands of the Nobert's plate.

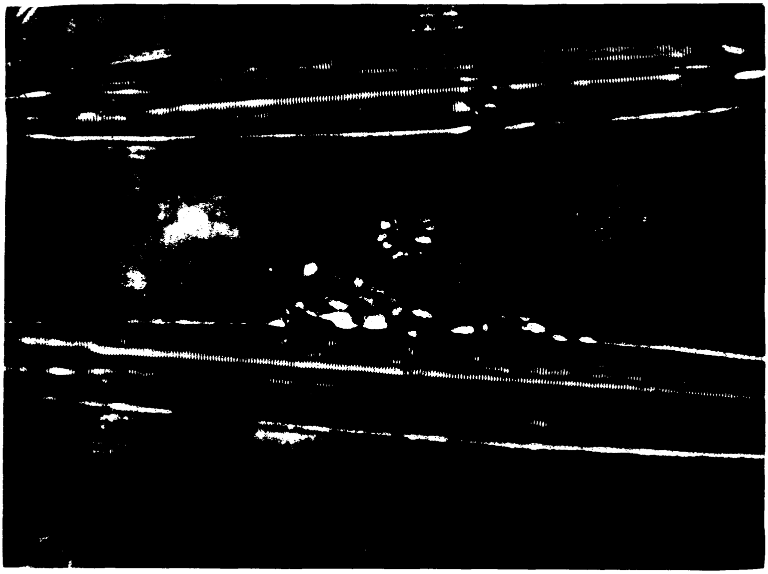
My present object is not to advocate one maker or another, but to present an image of what the best glasses of several excellent makers will do with ease if properly handled, and to those who are influenced by more partisan feelings I need only suggest that less than two years ago no American microscopist had been able to see any striæ on this well marked diatom, and that those who had made the attempt were disposed to regard the observations of the Hull naturalists, made over ten years before, as quite fictitious.

In conclusion I need only mention that the illustrative print was reproduced from my negative by "The American Photo-relief Printing Company" No. 1002 Arch Steet, Philadelphia, Pa.

## WHAT IS TRUE TACONIC?

BY PROF. JAMES D. DANA.

THE true use of the term Taconic should be learned from Prof. Emmons's first application of it when he made his formal announcement of the "Taconic system." In his final New York



*TWO FRUSTULES OF*

AMPHIPLEURA PELLUCIDA,

MAGNIFIED 1500 DIAMETERS.

PHOTOGRAPHED BY

**DR. J. J. WOODWARD, U. S. ARMY,**

AT THE ARMY MEDICAL MUSEUM.

*Objective by WM. WALES, Fort Lee, N. J.*